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# AUSTRALIA

## Patents Act 1990

**Aaqua Clarus Holdings Pty Ltd**

### PROVISIONAL SPECIFICATION

*Invention Title:*

*Method and apparatus for the onsite treatment of organic  
waste*

The invention is described in the following statement:

### Field of the Invention

The invention relates to an apparatus and method for the onsite treatment of waste products, including solid and liquid domestic and human wastes.

### 5 Background of the Invention

With increasing population densities, the disposal of domestic and human waste to a suitable location is becoming increasingly difficult and hence costly. For remote communities, areas at the fringe of large cities, and rural areas, the problem is often the lack of appropriate sewerage facilities  
10 which can lead to contamination of water supplies.

A number of onsite treatment systems have been developed that are designed to minimise the level of waste leaving a property. Most, however, have relatively high operating costs and require a rigorous and regular service regime to ensure their continuing efficient operation.

15 A large number of primary treatment systems for sewerage involve an anaerobic process, with the septic tank being one example. Odours from such tanks can however, be troublesome and subsequent treatment needs to be more extensive than for an aerobic process. In addition, these systems require a periodic pump out of sludge. Septic systems are also becoming less  
20 popular with regulatory authorities because of their potentially harmful effect on the environment. Many alternative systems have also not received favour due to reliability problems and the fact that they generally require use of chlorine for disinfection.

A number of aerobic treatment systems have been developed but the  
25 majority of these use blowers or other mechanical means of aeration which generally eventually lead to reliability problems. Some systems have been developed that use passive aeration coupled with the use of worms and microbes. One such system is described in Australian Patent Application Nos 31013/93 and 51386/96. The process involving passing the waste through a  
30 bed of suitable filtration material containing a population of composting worms or microbes. The filtration bed of this system is relatively large in area and all liquids and solids pass through the bed. The bed is described as having filtration qualities but this is countered by lack of control of the filtration process. Excess water passing through the filtration bed is also not  
35 considered conducive to high levels of worm activity within the device. The effluent from this process is suitable for trench irrigation but to upgrade the

effluent such that it is suitable for surface dripper irrigation using conventional sand filtration is costly.

The present invention comprises an apparatus that has as a desired feature a capability to provide a suitable level of waste treatment at reasonable cost.

Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is solely for the purpose of providing a context for the present invention. It is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present invention as it existed in Australia before the priority date of each claim of this application.

#### Summary of the Invention

Throughout this specification the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

The present invention is a chamber for treating liquid and/or solid waste in which at least a proportion of the liquid in the waste stream is removed from the solid waste prior to the waste stream undergoing treatment. Removal of a proportion of the liquid, more preferably the majority of the liquid, has been found to facilitate the solid waste decomposition process.

According to one aspect, the present invention comprises a waste treatment apparatus comprising a chamber having at least a first waste treatment zone, an inlet in the chamber through which a liquid and solid waste stream can enter the chamber, and a separating means downstream of the inlet which separates at least a proportion of the liquid waste from the solid waste prior to the solid waste entering the first waste treatment zone.

In one embodiment of the invention, more than about 80% of the liquid in the waste inlet stream is separated from the solid waste by the separating means. More preferably, more than 85% of the liquid in the inlet stream is separated from the solid waste by the separating means. Yet more preferably more than 90% of the liquid in the inlet stream is separated from the solid waste by the separating means. Still more preferably, more than 95% of the

liquid in the inlet stream is separated from the solid waste by the separating means.

In a further embodiment, the inlet is a pipe that extends from the source of the waste, eg a domestic toilet or sink drain, to a central location in the chamber. The outlet of the inlet preferably faces downwardly such that the waste stream enters the chamber in a generally downward direction. A skirt can extend about the outlet of the inlet. The skirt is preferably formed from a flexible material, such as a geotextile. The skirt preferably serves to dampen the rush of the inlet stream into the chamber and also ensures relatively even distribution of the waste stream.

The separating means preferably comprises a separation cone positioned immediately below the inlet. The apex of the cone preferably extends upwardly. The skirt of the inlet preferably extends down to just above or into contact with the separation cone below its apex.

The upper surface of the cone is preferably formed from a porous membrane. The porous membrane preferably comprises a woven mesh material. The woven mesh can be formed from polymeric fibres. The porosity of the membrane is preferably such that the liquid in the waste stream preferentially passes through the membrane to be collected therebeneath. Solids caught by the membrane of the separation cone preferably slide down or bounce outwardly off the membrane surface and then fall into the first treatment zone.

While the solids preferentially are separated into the first treatment zone, it will be appreciated that some solid matter having dimensions smaller than that of the pores of the porous member may pass through the porous member.

The first treatment zone preferably includes one or more support screens disposed horizontally across the zone. In a preferred embodiment, the first treatment zone has three separate screens disposed thereacross. The screens are preferably disposed one above the other and are separated by substantially equal distances. The upper screen preferably has a porosity greater than that of the next screen disposed therebelow. Said next screen in turn preferably has a porosity greater than that of the still further screen disposed below it. The upper screen can be formed, at least in part, from 25mm woven mesh material. The screen below the upper screen can be

formed, at least in part, from 13mm woven mesh material. The still further screen can be formed, at least in part, from 5mm woven mesh material.

Each support screen preferably has one or more baffles that retain solid material on the support screen. The baffles serve to assist in retaining the solid material in the first treatment zone for a period sufficient to ensure appropriate decomposition. The baffles of the upper screen are preferably offset from those of said next screen therebelow. Again, in turn, the baffles of the still further screen are also offset from those of said next screen. The offset of the baffles serves to assist in preventing solid waste travelling directly downwardly without spending at least some time on the support screens in the first treatment zone.

The support screens preferably surround a compartment containing a population of worms and/or suitable composting organisms. The population of worms and/or other suitable organisms are preferably introduced into the chamber following its installation. The compartment has at least one porous wall to allow the worms and/or other suitable organisms to exit the compartment and move out onto the support screens. The worms and/or other suitable organisms consume the solids and produce decomposed waste that can fall still further downwardly through the first treatment zone. Eventually, relatively small diameter particles reach the bottom of the zone.

The first treatment zone is ventilated to promote aerobic conditions within the zone at all times.

A lower membrane is provided at the bottom of the first treatment zone. The relatively small particles build up on this lower membrane. The lower membrane preferably rests on drainage cells that allows any liquid that has passed downwardly through the first treatment zone to enter a well. The well is preferably centrally disposed in the first treatment zone. As the solids build up on the lower membrane they preferably fall into the centre well where they remain until pumped out by a pump means. The pump means in the centre well is preferably activated when the liquid therein reaches a predetermined detected height. Alternatively, the pump means can be activated on a predetermined regular basis, subject to there being water present in the centre well.

The solids and liquid are preferably pumped to a storage means. The liquid pumped from the centre well of the first treatment zone to the storage means preferably can pass through the storage means and undergo further

processing as described below. The storage means is preferably disposed near the top of the chamber and is accessible to allow removal of the solids stored therein. In one embodiment of the use of the chamber, it is envisaged that the waste will be removed on approximately an annual basis from the storage means.

In another embodiment, the solids and liquid can be pumped to an external trench.

The proportion of liquid separated from the waste stream by the separating means is preferably processed in a second treatment zone of the chamber. The second treatment zone can comprise at least one layer of trickle bed media. In a more preferred embodiment, the second treatment zone comprises at least one bed of relatively coarse trickle bed media and at least one layer of relatively fine trickle bed media. The relatively coarse trickle bed media can comprise chopped up agricultural pipe (eg 63mm diameter) and the relatively fine trickle bed media can comprise peat moss. In yet a more preferred embodiment, the second treatment zone comprises a plurality of layers of relatively fine and relatively coarse trickle bed media. The second treatment zone preferably comprises alternate layers of relatively coarse and relatively fine trickle bed media.

Each of the layers of relatively coarse trickle bed media are preferably well ventilated. The layers of relatively fine trickle bed media are preferably not well ventilated and act as anaerobic pockets within the second treatment zone. Bacteria will preferably form within the trickle beds and so reduce the BOD of the liquid as it passes through the second treatment zone. Where used, the alternate layers also preferably facilitate destruction of some nitrogen by a process of nitrification and denitrification.

In a preferred embodiment, the liquid separated by the separated means is introduced into the second treatment zone at a position separated from the top of the zone. In one embodiment, the separated liquid is introduced at a position about midway between the top and bottom of the second treatment zone.

In a preferred embodiment, the second treatment zone is annular and surrounds the first treatment zone. At least a portion of the wall separating the first and second treatment zones can be porous. The porosity of said portion of the wall assists in maintaining good ventilation in the respective zones. Said porous portion also allows liquid that enters the first treatment

zone to be shed outwardly through the porous portion of the wall into the second treatment zone. The various layers of trickle bed media can have baffles or horizontal pipes positioned therein to assist in ensuring liquid moving outwardly into the second treatment zone is transported well into the zone.

5 The chamber preferably includes a liquid collection zone positioned beneath the second treatment zone. The liquid collection zone preferably includes a pumpwell. A pump means preferably can transport liquid collected in the pumpwell to a further liquid processing system. In another  
10 embodiment, the liquid can be pumped to a subsurface trench or used for irrigation.

As described above, liquid pumped from the centre well of the first treatment zone can pass through the storage means. This liquid preferably enters the top of the second treatment zone and passes downwardly  
15 therethrough. In this embodiment, any liquid that enters the first treatment zone is also at least processed by the second treatment zone before leaving the chamber. The storage means can comprise a collection sock which traps the solids pumped from the centrewell but allows the pumped liquid to pass therethrough into the second treatment zone.

20 The pump means within the pumpwell of the liquid collection zone is preferably controlled by a float switch and controller which activates the pump means at set times or when the liquid level in the pumpwell reaches a predetermined level. In addition to activating the pump means, the float switch and controller preferably opens a valve in a liquid line between the  
25 pumpwell and the liquid processing system. When the liquid level in the pumpwell has fallen to a predetermined minimum level, the float switch and controller switches off the pumping means and closes the valve. Alternatively, the pump means can be activated on a predetermined regular basis.

30 In a further embodiment, the apparatus preferably includes a controller means that controls the operation of at least some components of the apparatus. The controller means, after firstly checking that there is sufficient liquid in the pumpwell of the liquid collection zone, can be adapted at regular intervals to open a further valve in the liquid line and activate the  
35 pump means so as to direct liquid into a recirculation circuit. The liquid flow rate and/or the time of recirculation is preferably adjusted to ensure the



relatively fine trickle media in the second treatment zone does not flood. The recirculation circuit is preferably connected to a plurality of liquid nozzles positioned above the trickle bed media so the liquid is recirculated through the trickle bed. Such recirculation of the liquid assists in promoting BOD reduction. The frequency of recirculation of the liquid is preferably adjustable by making appropriate modification of the controller means. In any event, recirculation once activated will normally continue for a pre-set time period or until the float switch assembly detects a minimum level of liquid in the pumpwell. The frequency also controls the amount of the bed operating in an anaerobic state compared with an aerobic state and thus the amount of nitrogen removal by a process of nitrification/denitrification.

The controller means can be still further adapted at regular intervals (for example, once a day) to open another valve in the liquid line and activate the pump means so as to direct liquid into a liquid circuit that sprays liquid onto the separating means. In one embodiment, liquid is directed upwardly from the underside to prevent the build up of solids that would block the membrane preferably used for this device. This liquid can be drawn from the liquid collection zone. In another embodiment, the liquid can be drawn from the further liquid processing system.

In an additional embodiment, solid organic waste, such as kitchen scraps, paper and the like can be added to the first treatment zone by placing them through an orifice formed in the upper side of the chamber. Such waste will preferentially fall down onto the upper screen.

As described above, the liquid can be pumped to a further processing system. The further processing system is preferably used where relatively high quality effluent is required. The further processing system can comprise a treatment chamber containing at least an ozone treatment system. This treatment chamber can be internal or external of the chamber defined above. The treatment chamber can also comprise a filtration device to further upgrade the quality of the liquid. The filtration device can comprise a sand filter. The filtration device can also contain other media, such as zeolite. The further processing system can further include a treated water storage zone.

In one embodiment, the pump means in the liquid collection zone pumps the liquid through the filtration device of the further processing system to the ozone treatment system. The controller means preferably isolates the ozone treatment system by shutting valves on both the inlet and

outlet line, and opening a valve on a recirculation line and activating an ozone generator. The recirculating liquid is then passed through a venturi connected to the ozone generator and then returns to the treatment tank. After treatment for a preset time, the controller operates valves to allow liquid to pass through a filter means to a treated water collection tank. This filter would typically contain carbon to further eliminate colour and odours. The ozone treatment system is preferably operated under pressure to maximise the dissolution of ozone in water.

5 The controller means is further preferably adapted at regular intervals to open valves that direct liquid in a reverse direction through the filter and carry solids collected on the filter to the storage means situated in the treatment chamber described above. As described, the storage means is adapted to allow liquid to pass therethrough and re-enter the trickle bed media in the second treatment zone. Any solids trapped in the storage means can be periodically removed during service of the apparatus.

10 In a further embodiment, the controller means can be linked to a central monitoring station to ensure the system is functioning effectively at all times and collect performance data. The controller means can also integrate with other onsite systems to maximise the overall sustainability of the site.

20 According to a further aspect, the present invention is a waste treatment apparatus comprising a chamber having at least a first waste treatment zone and an inlet in the chamber through which a liquid and solid waste stream can enter the chamber, the first treatment zone including a first screen and at least a second screen disposed at least substantially horizontally across the zone, the first zone positioned being positioned above the second screen and having at least a region having a porosity greater than at least a region of the second screen.

25 In a preferred embodiment of this aspect, the first and second screens are formed of a woven mesh material. The woven mesh can be formed from polymeric fibres. The mesh of said portion of the second screen can have a smaller gauge than that of said portion of the first screen. In one embodiment, the screens can be formed of woven nylon fibres.

30 The screens preferably extend horizontally across the first treatment zone of the chamber.

In a further embodiment of this aspect, the first treatment zone can comprise at least three screens, ie. the first screen, the second screen and a third screen. Where the third screen is positioned below the second screen, the porosity of at least a region of the third screen is preferably less than that of said portion of the second screen.

The screens are preferably disposed one above the other and are separated by substantially equal distances. The first upper screen can be formed, at least in part, from 25mm woven mesh material. The screen below the upper screen (ie. the second screen) can be formed, at least in part, from 13mm woven mesh material. The still further screen (ie. the third screen) can be formed, at least in part, from 5mm woven mesh material.

Each of the screens preferably has one or more baffles that retain solid material on the screen. The baffles serve to assist in retaining the solid material in the first treatment zone for a period sufficient to ensure appropriate decomposition. The baffles of the first screen are preferably offset from those of the second screen therebelow. Again, in turn, the baffles of the third screen are also offset from those of the second screen. The offset of the baffles serves to assist in preventing solid waste travelling directly downwardly without spending at least some time on the screens in the first treatment zone.

The screens of this further aspect preferably surround a compartment containing a population of worms and/or suitable composting organisms. The population of worms and/or other suitable organisms are preferably introduced into the chamber following its installation. The compartment has at least one porous wall to allow the worms and/or other suitable organisms to exit the compartment and move out onto the screens. The worms and/or other suitable organisms consume the solids and produce decomposed waste that can fall still further downwardly through the first treatment zone. Eventually, relatively small diameter particles reach the bottom of the zone.

The chamber of the further aspect can further have one or more features of the chamber of the first aspect if the invention defined herein.

In a further embodiment, the treatment apparatus can comprise two or more chambers according to the present invention.

According to a second aspect, the present invention comprises a method of treating a liquid and solid waste stream comprising the step of passing the waste into an inlet of an apparatus as defined herein.

### Brief Description of the Drawings

By way of example only, preferred embodiments of the invention are now described with reference to the accompanying drawings, in which:

Fig. 1 is a simplified vertical cross-sectional view of an apparatus according to the present invention;

Fig. 2 is a horizontal cross-sectional view of the apparatus of Fig. 1;

Fig. 3 is an enlarged plan view of components of the first treatment zone according to one embodiment of the present invention;

Fig. 4 is a simplified vertical cross-sectional view of an additional liquid processing apparatus according to the present invention; and

Fig. 5 is a horizontal cross-sectional view of the apparatus of Fig. 4.

### Preferred Mode of Carrying Out the Invention

An apparatus for the treatment of wastewater generated from a typical domestic house is depicted generally as 10 in the accompanying drawings.

The apparatus 10 can be installed either above or below ground level. The chamber 10 is aerated through a number of vents 35.

The apparatus 10 consists of a first treatment chamber 11. Liquid and solid waste enters the chamber 11 through waste pipe 12. The outlet of the pipe 12 is positioned above a separation cone 13. The end of the pipe 12 has a flexible geotextile skirt 14 which serves to dampen the rush of the waste stream onto the cone 13.

The cone 13 is formed from a porous woven mesh membrane that allows at least a proportion of the liquid in the waste stream to pass therethrough. Preferably, the cone 13 is formed so as to ensure that at least 85%, more preferably about 95%, of the liquid (eg. water) in the waste stream is separated from the solid waste.

The liquid that passes through the cone 13 collects in a tray 15 and then drains through two exit pipes 16 set 180° apart into a funnel 17. From here the liquid is distributed by pipe 18 into a second treatment zone 30. The liquid is preferably distributed relatively evenly into zone 30 by pipe 18.

The majority of the solid waste in the inlet stream and the relatively small quantity of liquid is deflected by separating cone 13 outwardly before falling downwardly onto top tray 21 of a first treatment zone 20. As depicted in Fig. 3, the top tray 21 is comprised of alternating regions of relatively coarse mesh 22 (25mm gaps) and relatively fine mesh 23 (eg. shaded cloth).

Worms, other living organisms, wormcast and fibre mix are introduced into the centre chamber 24 prior to commissioning of the apparatus 10. The worms and other living organisms can move through the porous wall of the centre chamber 24 to the waste caught on the tray 21.

5        Smaller material and decomposed larger material falls through the top tray 21 onto the middle tray 25 below where it again is consumed by the worms and other living organisms that have moved out of chamber 24. The middle tray 25 also has alternating regions of coarse mesh 22 (13mm gaps) and fine mesh 23. The regions of fine mesh 23 of middle tray 25 are offset  
10        such that the fine mesh 23 of the middle tray 25 is positioned below the coarse mesh regions 22 of top tray 21. In this way, any solid material that falls straight through top tray 21 is caught by the middle tray 25.

      As the material on the middle tray 25 breaks down it falls to a third bottom tray 26 where it again can be consumed by the worms and other living  
15        organisms that have moved out of chamber 24. Bottom tray 26 again has regions of relatively coarse mesh 22 (5mm gaps) and fine mesh 23 (eg. shadecloth). The fine mesh 23 of the bottom tray 26 is again offset from that of the middle tray 25 such that matter that falls through the mesh 22 of the middle tray 25 preferably lands on the fine mesh 23 of bottom tray 26.

20        Once the material falls through bottom tray 26 it builds up on the bottom of the first treatment zone 20 on a bed of fine fibre 27 supported on a membrane 28 and drainage cells 29 that are placed in the first zone 20 during start-up.

      As the solids build up on bed 27 they fall into the centre well 31. Some  
25        liquid also flows into this well 31 either with the solids or through drainage holes 32 from drainage cells 29. Pump 33 in well 31 is activated when the liquid reaches a predetermined height. The solids and the liquid in well 31 are then pumped to an annular distribution pipe 34 and pass through small  
30        holes into a collection tube consisting of agricultural pipe covered by filter sock. The solids are retained in the tube for removal during an annual service of the apparatus and the liquid preferably passes through the sock into the top of the trickle bed of the second treatment zone 30.

      The second treatment zone 30 is separated from the first treatment zone 20 by a wire screen and porous shadecloth membrane 36 in the upper  
35        section of the chamber 11 and by an impervious membrane 37 at the base of the chamber 11. The base 37 is supported by a pipe support 38. Aerobic

bacteria form within the trickle bed of the second treatment zone 30 and this reduces the BOD in the wastewater as it passes through this zone 30.

The liquid leaving the trickle bed 30 passes into the collection chamber 39. The liquid from the collection chamber 39 flows into pump well 41 where it is pumped by pump 42 out of the chamber 39. The liquid can be recycled back through the trickle bed of the second treatment zone 30, pumped to a granular filter 60 of a further liquid treatment apparatus 60, or used for cleaning the separation cone 13.

The liquid is recirculated to the trickle bed of the second treatment zone 30 through annularly disposed, downwardly directed nozzles 43. The frequency of recycle is set by a controller to maximise BOD reduction in the second treatment zone 30. The recirculation continues either until a low level float probe in well 41 is activated or the recycle time set in the controller is exceeded. The liquid passes down through the bed 30 which comprises a alternate layers of fine media 44, such as peatmoss, followed by course media 45, such as chopped up 63mm agricultural pipe. Each layer of the course media 45 is ventilated through holes in vent pipe 35.

Liquid passing through the separation cone 13 and entering the trickle bed through distribution pipe 18 passes through at least one layer of fine trickle media 44 and one layer of course media 45 before it enters collection chamber 39.

At preset intervals of say 1 minute per day, the controller can open a valve and a preset quantity of treated water can be pumped to the cone 13 through pipe 46 to clean any accumulated solids off the membrane 13. The liquid is directed tangentially across the membrane 13 through a slit around the circumference of nozzle device 47 and also up through the screen through nozzles 48. The washing time is set prior to pump out to ensure there is always water available for cleaning.

The apparatus can include a high level probe, connected to a visual alarm with buzzer positioned within the house, to signal a malfunction of the system and to ensure manual override of the pump 42 when required.

At preset times or when the high level probe is activated, the liquid in the collection chamber 39 can be pumped through pipe 49 to a further liquid treatment apparatus 60 (see Fig. 4). The depicted apparatus 60 includes a granular filter 61 and an ozone treatment tank 62. Pump out of chamber 39 stops when the low level probe in well 41 is activated. Once liquid has been

transferred into apparatus 60, a recirculating pump 63 and ozone generator are started and ozone is added to the water through a venturi. The duration of treatment is established by controller 70. After treatment, valves are opened and the water is pumped to the treated water tank using the  
5 recirculating pump 63.

A pressure pump 64 is positioned at the outlet of the treated water tank to pump treated water out of the system through a small polishing filter.

At preset intervals, the controller 70 opens solenoids and a small quantity of treated waste from the first treatment tank is backwashed through  
10 the filter to the solids collection tube in the first chamber 11. The valve is then set to a rinse for a short period (returning liquid to the treatment tank until it becomes clear) before moving to the original position allowing flow to the treatment.

The chamber 60 can be positioned mostly above ground level. In cases  
15 where there is secondary treatment of the liquid in chamber 60, an alternative is for the solids to overflow into the water in the bottom of the chamber 11 and be separated in the sand filter 61 within the second treatment chamber 60.

It will be appreciated by persons skilled in the art that numerous  
20 variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

Dated this tenth day of May 2001

Aaqua Clarus Holdings Pty Ltd  
Patent Attorneys for the Applicant:

F B RICE & CO

Fig 1

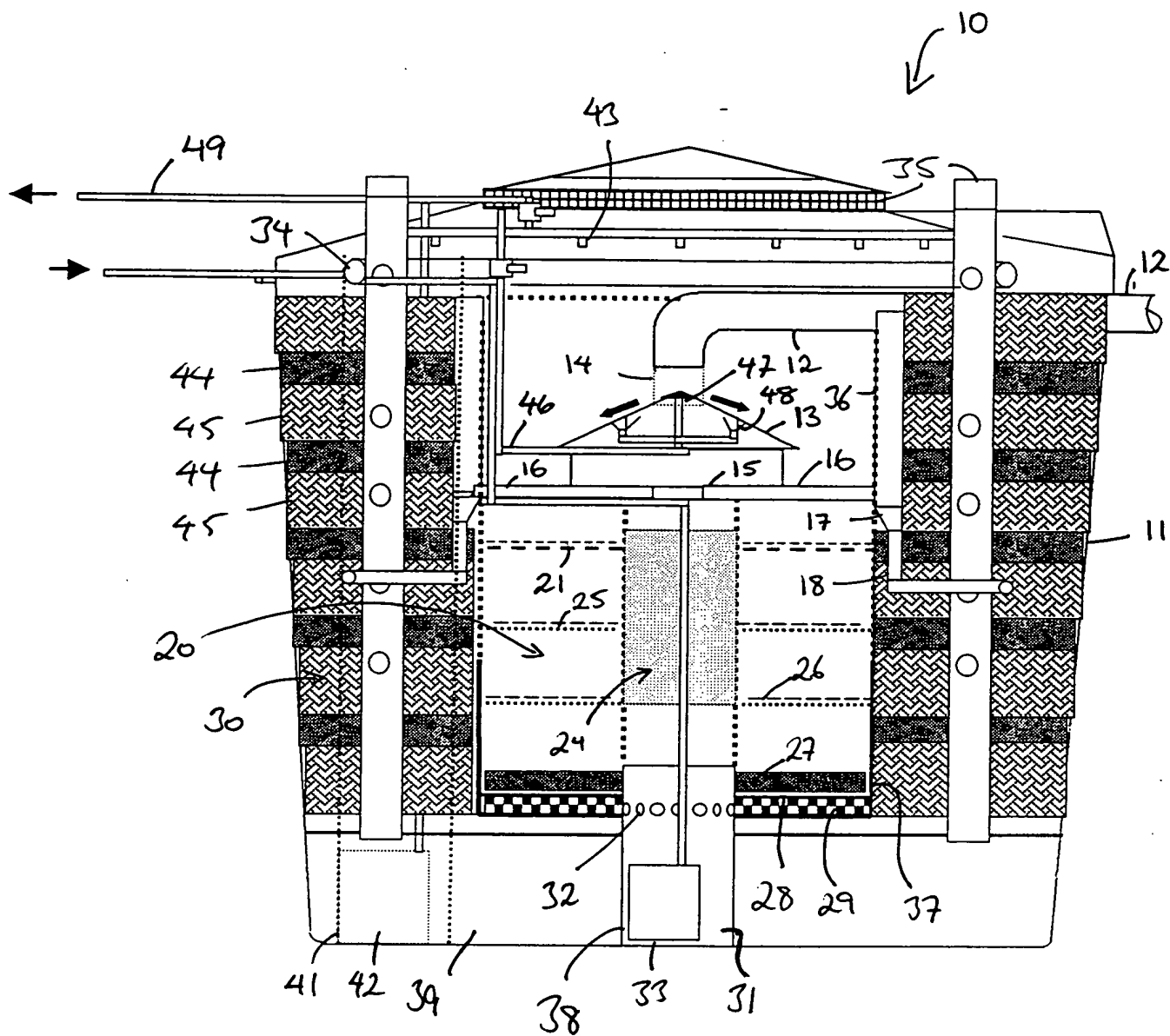




Fig 2

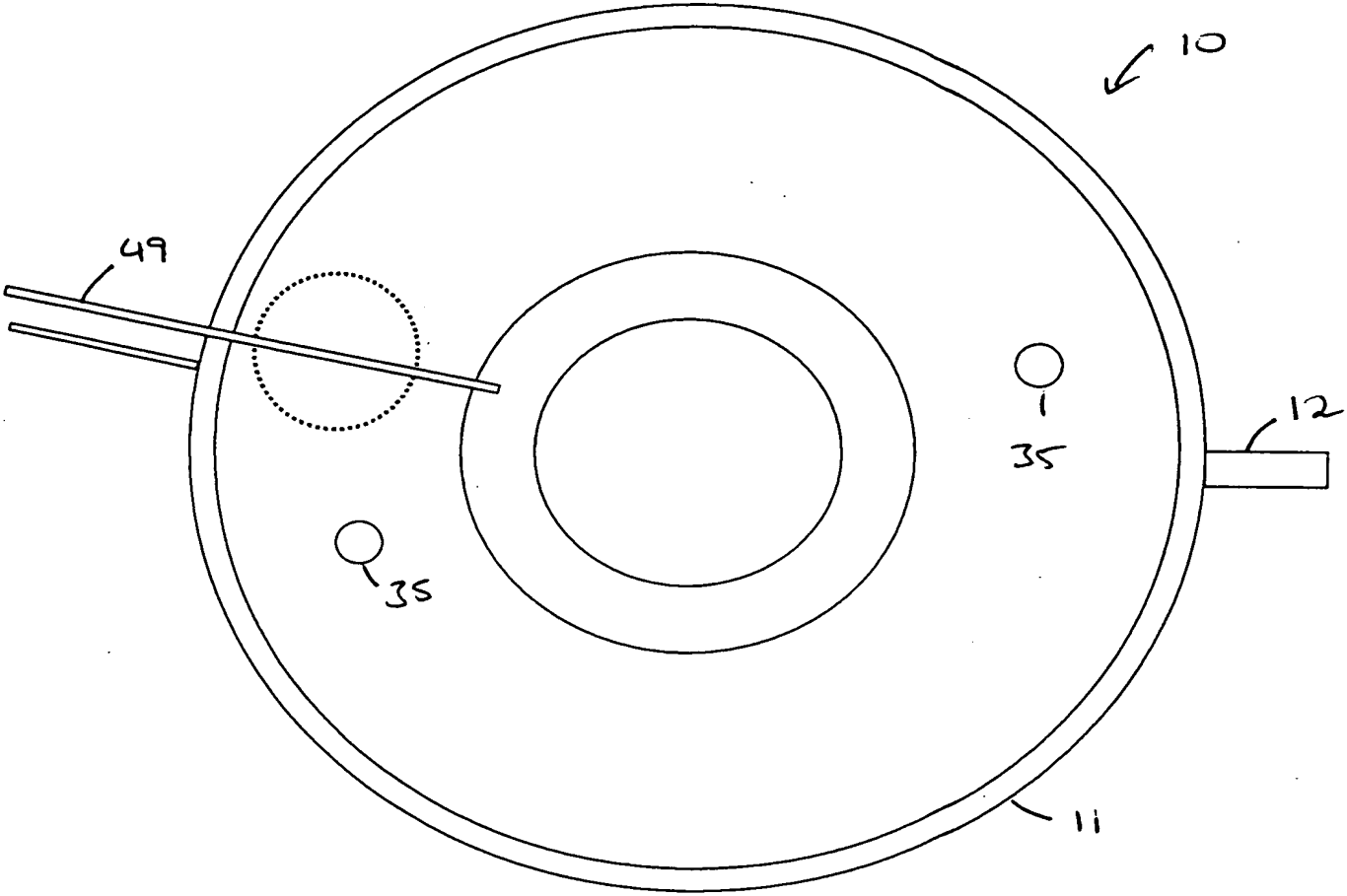


Fig 3

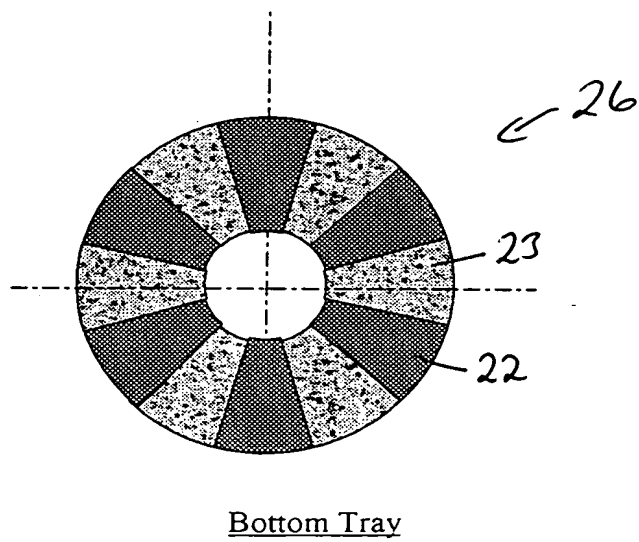
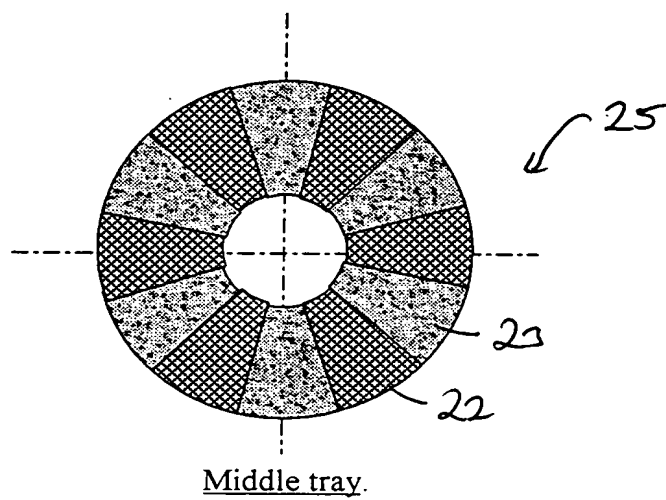
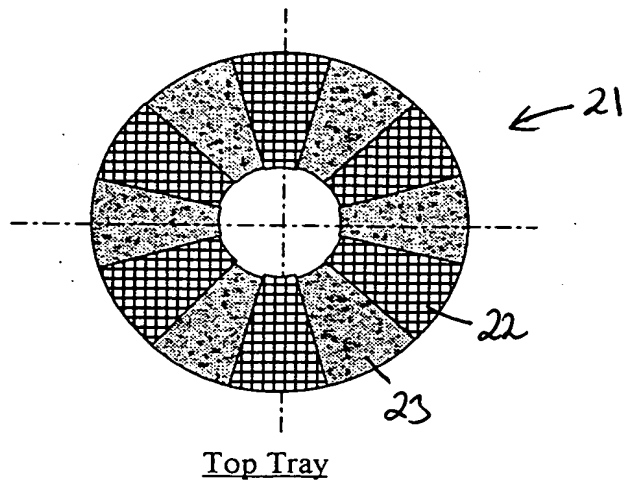


Fig 4

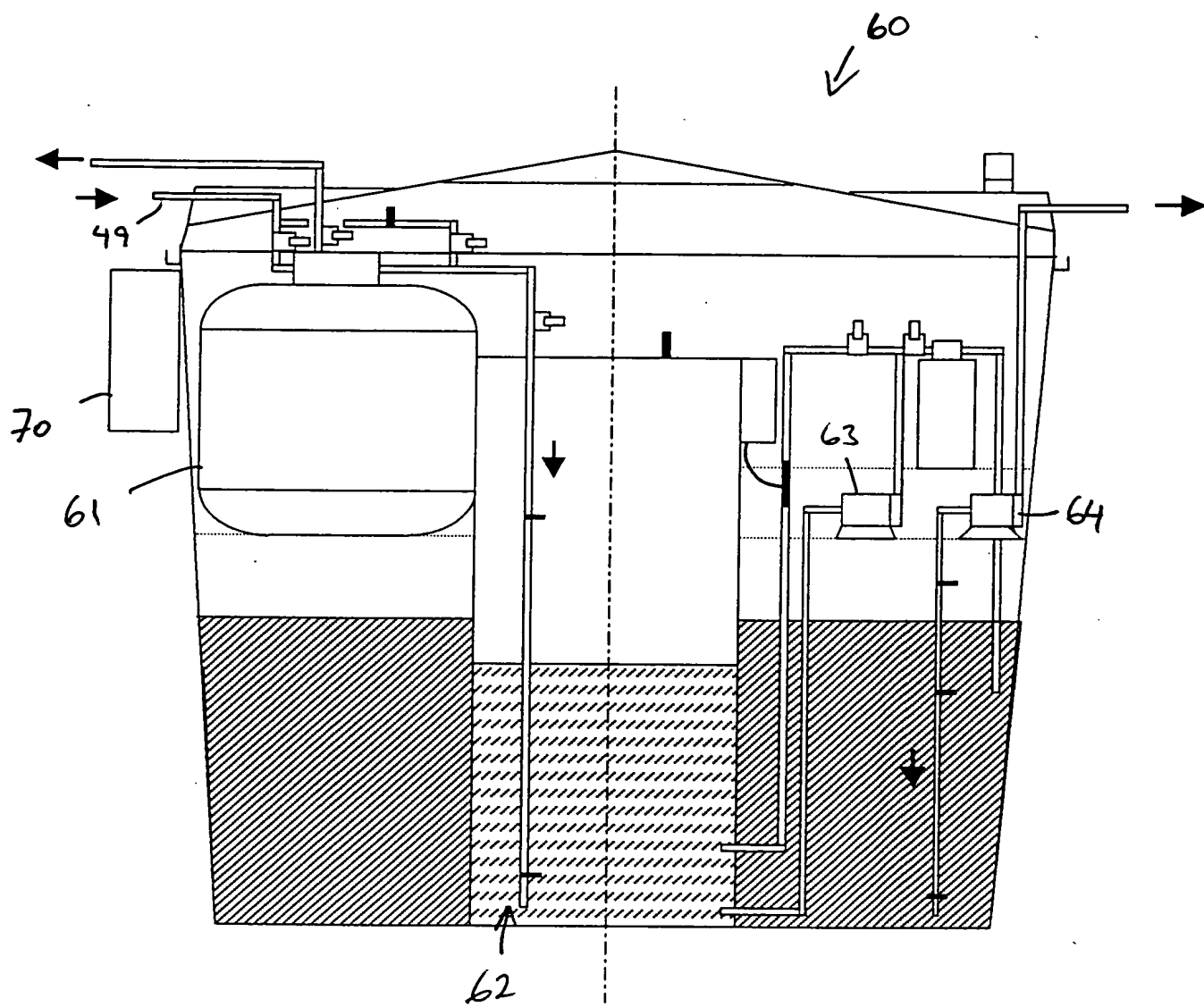


Fig 5

